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ABSTRACT

Prepared in response to a request for information from the chairman of the House of Representatives Subcommittee on Telecommunications and Finance, Committee on Energy and Commerce, this report provides information on 14 high-definition television (HDTV) applications spanning national defense, medical research, space exploration, and electronic publishing. The opinions of industry officials concerning the effects that establishing HDTV production standards would have on such applications are reported, and HDTV is defined as the next generation in video technology, with a picture that is both wider and twice as sharp as those currently appearing on television sets in the United States. The improvement in picture clarity is caused by increasing the number of scanning lines from the current American standard of 525 lines to 1,125 lines, which is the current Japanese standard. The purpose of this report is to provide preliminary information to the House Committee on Energy and Commerce, the House Committee on Government Operations, the Secretary of Defense, the National Aeronautics and Space Administration, and the Director of the Office of Management and Budget. (DB)

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Fact Sheet for the Chairman, Subcommittee on Telecommunications and Finance, Committee on Energy and Commerce, House of Representatives

December 1989

HIGH-DEFINITION TELEVISION

Applications for This New Technology

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Information Management and
Technology Division

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December 11, 1989

The Honorable Edward J. Markey
Chairman, Subcommittee on Telecommunications
and Finance
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

This report responds to your April 28, 1989, letter, which asked us to identify uses for high-definition television (HDTV) technology. You also asked for information concerning the potential effect that the selection of an HDTV production standard would have on the development of nonentertainment applications in the United States.[1] In this report we provide information on 14 HDTV applications spanning defense, medicine, space exploration, and other areas that we identified during our review. In addition, we provide the opinions of key industry officials concerning the general effect that establishing an HDTV production standard would have on potential applications. As agreed with your office, we will discuss these standards, and the issues related to their adoption, in greater detail in a future report.

HDTV represents the next generation in video technology, with a picture that is wider and twice as sharp as the one currently appearing on television sets. This significant improvement in picture clarity and quality is made possible mainly by increasing the number of scanning lines from 525 (the American production standard for over 40 years) to over 1000 lines.[2] In addition, HDTV improves on regular television by its greatly enhanced color and its capability to deliver digital stereo sound.

HDTV Applications

Because of the dramatic improvement in picture quality, much of the interest in HDTV applications has centered on its potential uses in the television, motion picture, and consumer electronics industries. Industry officials believe that HDTV will have a significant economic impact on manufacturers of video cassette recorders, video cameras, television

[1] A production standard is an agreed-upon set of technical specifications that determine the manner in which audio and visual information is recorded to create a television picture. Production standards are applied to the design and manufacture of production equipment, for example, studio cameras. Other television standards involve the transmission and display of screen images.

[2] A television picture is created by rapidly scanning a phosphorescent screen with electrons, or scanning lines, which are invisible to the naked eye.

sets, and other associated equipment. According to one estimate, consumer sales of HDTV sets in the United States alone could exceed $20 billion a year by the late 1990s.

In addition to entertainment, we found there are a number of other applications for HDTV—spanning defense, medicine, space exploration, and other areas—that could be of use to both the public and private sectors. Because HDTV technology is relatively new, many applications have not progressed beyond the conceptual stage. The applications we have identified are those that are currently in production or are under development; therefore, our list of applications is not exhaustive. Appendix I contains more detailed information on the 14 HDTV applications that we identified during this review.

Production Standards

We found no consensus among industry officials on what potential effect a common production standard would have on the development of HDTV applications. Although numerous American researchers and manufacturers have proposed HDTV systems, they are based on widely varying production standards, in part because U.S. industry has not agreed on a single HDTV standard.[3] Thus, the systems developed in this country use anywhere from 787.5 to 1,200 scanning lines to produce high-resolution images. In contrast, Japanese industry has largely agreed on a system that produces images with 1,125 scanning lines, while a number of European countries have formed a consortium to work toward a single HDTV production standard.

The cost of HDTV production equipment can be reduced by having a common standard, according to a group of companies favoring a modified version of the Japanese production standard.[4] This group stated that if computer graphics, entertainment, research, medicine, retailing, and publishing could all share a common HDTV standard, volume would justify mass production of integrated circuits—key components in HDTV hardware—and costs would fall dramatically.

[3]Production standards are based on many technical parameters including aspect ratio, the number of scanning lines, color, luminance, and others. In meetings of the Consultative Committee on International Radio—an international standards-setting organization—agreement has been reached on many, but not all, of these parameters.

[4]The HDTV 1125/60 Group favors a standard endorsed by the Society of Motion Picture and Television Engineers (SMPTE) known as the SMPTE 240m standard. This standard is a slightly modified version of the Japanese standard, which has 1,125 scanning lines.

In contrast, other industry officials do not believe the lack of an overall production standard is currently affecting the ability of domestic manufacturers and others to develop HDTV applications and receive the projected economic benefits associated with them. According to these officials, the lack of an overall production standard has not been a factor in the initial development of uses for HDTV. Most of the nonentertainment applications identified at the present time are for closed-circuit systems in which the developer has independently determined the methods and standards for production, transmission, and display.

Applications of this type have already been developed in advance of any worldwide or domestic standards agreement. For example, one medical application involves transmitting high-definition pictures of pathology slides, via fiber optic cable, to a physician in another location for diagnosis. The developers of this system have designed a specialized high-definition camera, transmission system, and display that are most appropriate for this specific purpose. These officials acknowledged that, over the long term, mass production of HDTV equipment for entertainment purposes might reduce their equipment acquisition costs if a common standard were adopted.

Scope and Methodology

We obtained information on potential applications primarily through interviews with officials from 13 academic institutions, private sector firms, and research organizations knowledgeable about HDTV, as follows:

- Corabi Telemetrics International, Alexandria, Virginia;
- New York Institute of Technology, Computer Graphics Lab, Old Westbury, New York;
- Sony Corporation, New York City;
- New York Institute of Technology, Science and Research Lab, Dania, Florida;
- Massachusetts Institute of Technology, Cambridge, Massachusetts;
- David Sarnoff Research Center, Princeton, New Jersey;
- Telecommunications, Inc., Denver, Colorado;
- MITRE Corporation, McLean, Virginia;
- Japan Broadcasting Company, New York City;
- Bellcore, Red Bank, New Jersey;
- Xerox Corporation, Palo Alto, California;
- Quantel Corporation, Berkshire, United Kingdom; and
- COMSAT Corporation, Clarksburg, Maryland.

We also obtained and reviewed documents pertaining to HDTV from these organizations, including scientific studies and promotional material. Information on the effect of production standards on the development of nonentertainment applications represents the views of representatives from the 13 private organizations cited above.

We also interviewed key officials from government agencies that are analyzing HDTV issues and policy options, to obtain background on federal involvement in HDTV and information on potential government uses of HDTV technology. These agencies included the Federal Communications Commission, Defense Advanced Research Projects Agency, National Institute of Standards and Technology, National Telecommunications and Information Agency, National Aeronautics and Space Administration (NASA), and the Department of State.

Our work was conducted from June through September 1989, either at the locations cited above or in the Washington, D.C., metropolitan area. We did not obtain official agency comments on a draft of this report; however, during our review we discussed our findings with cognizant industry and government representatives. Their views have been incorporated into this report where appropriate.

As agreed with your office, we plan no further distribution of this report for 30 days from its issue date, or until you publicly release it. At that time, we will provide copies to the Chairman, House Committee on Energy and Commerce and the Chairman, House Committee on Government Operations. We will also provide copies to the Secretary of Defense; the Administrator, NASA; and the Director of the Office of Management and Budget. We will make copies available to other interested parties upon request.

This report was prepared under the direction of Jack L. Brock, Jr., who can be reached at (202) 275-3195. Other major contributors to this report are listed in appendix II.

Sincerely yours,

for Daniel C. White

Ralph V. Carlone
Assistant Comptroller General

Alternative Applications for HDTV

The potential for HDTV applications extends beyond the television and motion picture industry and includes such areas as defense, medicine, space exploration, and others. Because HDTV technology is relatively new, many applications have not progressed beyond the conceptual stage. The applications we have identified are those that are currently in production or are under development.

Defense Applications for HDTV

We found the largest number of applications for HDTV in the defense category. For its broad range of video applications in battle management, command and control, training and simulation, and intelligence analysis, the Department of Defense needs high-definition, low-cost, dynamic multimedia displays for presentation in motion video, real-time graphics, maps, and photographs. Recognizing this need, in December 1988, the Defense Advanced Research Projects Agency asked industry for systems proposals aimed at the agency's goal of improving currently available high-definition video technology while significantly reducing its cost. The agency has a total of $30 million to use in awarding research contracts. As of October 1989, six companies had been selected for HDTV research contracts.

Flight Simulators

The military needs to provide its pilots realistic combat training; however, flight schools limit the number of aircraft in actual fight and air-ground interaction for safety and cost reasons. Networked visual display simulators can provide training realism by having large numbers of aircraft interact in simulated combat activities without sacrificing safety. According to officials at the Defense Advanced Research Projects Agency, HDTV efforts will facilitate purchasing inexpensive visual display devices for simulators, thus allowing more realistic combat training.

Cockpit Displays

Technological advances in cockpit display systems in aircraft are lagging when compared to the advances in sensor systems. Current aircraft panels are limited in size and depth; designers must integrate more data on to fewer, higher resolution displays. According to one Defense analysis, HDTV displays and processors will facilitate flight data presentation while reducing cockpit display costs by an estimated 33 percent.

Large Screen Displays in Command, Control, Communications, and Intelligence Centers

These centers have a requirement to display, transmit, receive, and resolve electronic map symbology and intelligence data. High-resolution-display technology is required because current television does not provide adequate detail to command, control, communications, and intelligence planners. Video teleconferencing using HDTV displays could rapidly disseminate detailed information to war planners in a crisis.

Defense Mapping

The Defense Mapping Agency is converting to 100 percent digital information for use in its map products. The agency has a large requirement for high-resolution systems to aid in the development, storage, editing, and transmission of these products. Current technology forces the agency to use expensive, customized systems. According to Defense Mapping officials, HDTV would allow the agency to purchase off-the-shelf equipment, greatly reducing total operating costs.

Real-Time Video Processing

HDTV can provide instant, high-resolution images for such purposes as air reconnaissance that are the near equivalent of photographs made from 35-millimeter film. For example, the Air Force plans to replace 35-millimeter, air-reconnaissance cameras with video cameras, thus eliminating the logistics and time lags involved in processing film.

Medical Uses for HDTV

The clear, high-resolution images provided by HDTV can assist medical personnel in making diagnoses and in educating medical students. HDTV, with its ability to provide instantaneous pictures of tissue slides, trauma patients, and surgical procedures, is ideally suited to be used as a medium for recording and reviewing medical events.

Pathology

One of the first commercial applications of a form of HDTV has been in the area of pathology. The system, developed by Corabi Telemetrics Inc., uses a fiber optic video link to give pathologists at distant locations the opportunity to analyze tissue samples through a computer hookup. The system uses a form of HDTV that produces an image sharp enough for doctors to make diagnoses. According to Corabi President Beth Newburger, "Pathologists have the most exacting requirements of a video image of any physicians who work in medicine." This kind of long-distance diagnosis was not possible with regular television, which lacks sufficient picture quality and resolution.

Medical Education

Teaching institutions have a need to provide real-time observation of surgical procedures to students. High-definition images of precision surgical techniques or of microsurgery procedures can be used to educate students about these techniques. During microsurgery, for example, there is sufficient space in the operating room for only a few students to observe the procedure. With HDTV, however, a larger number of students can observe and learn about the procedures from a remote location.

Space and Scientific Uses for HDTV

HDTV technology may also be of use in NASA programs. The agency has already experimented with the use of HDTV for launch control and evaluation for the space shuttle. In addition, NASA is examining the potential uses of HDTV for the Space Station Freedom program.

Launch Control and Evaluation

In 1988, NASA, in cooperation with Bellcore—a research consortium serving seven regional Bell operating companies—and other companies, demonstrated an experimental fiber optic network for HDTV, which televised the launch of the space shuttle Discovery. The objectives of this experiment were to evaluate currently available HDTV technology for (1) accessibility, (2) adaptability to the unique requirements of launch control, and (3) suitability for real-time image analysis. For the experiment, images of the launch were distributed, via fiber optic cable, to displays at the Launch Control Center, a press site, and to the University of Central Florida—about 50 miles away—where officials were observing. In addition, the HDTV pictures produced by the four cameras used were recorded individually for later technical analysis.

According to NASA, the test was highly successful. The resulting pictures exceeded the resolution of conventional television pictures by 70 percent and provided valuable information to NASA engineers. Although launches have previously been filmed using 35-millimeter film, the use of HDTV results in pictures of comparable resolution that can be played back and viewed immediately without waiting for film to be developed. In addition, Bellcore believes that such pictures offer the basis for a wide range of diagnostic capabilities. For example, during launch, data relating to shock, stress, control, and positioning can be seen in greater detail and acted upon, while also being recorded for immediate evaluation by mission scientists and engineers. In addition, by putting the video image into a digital format and using computers to enhance the image, scientists can focus on particular sections of the space shuttle for very close analysis. This procedure could be particularly helpful, for

example, in monitoring external fuel tanks, which are extremely susceptible to fire.

Space Station Freedom

NASA also envisions that HDTV technology could be used aboard the Space Station Freedom for space operations, scientific investigations, and information dissemination. The space station, which is expected to be operational in the 1990s, is planned as a permanently manned, multipurpose facility with a long lifetime. Specific examples of HDTV applications for the space station include:

- Space operations: HDTV technology could be used to facilitate such tasks as grappling, in which items outside the station are manipulated using a robotic arm while astronauts inside the station observe the process through a high-definition monitor. This use of a high-definition monitor will relay sufficient information for precise execution of tasks in unknown surroundings. In addition, high-definition cameras could be used to record detailed images both inside and outside the space station that can be transmitted back to earth for immediate analysis.
- Scientific investigations: HDTV could be useful to record scientific experiments in which changes occur either very slowly or very quickly. Scientists could then observe the high-definition tape and measure the changes in minute detail.
- Information dissemination: HDTV could be used to send high-quality video images from the space station to earth, as part of NASA's mission to disseminate information about its programs to the public. NASA officials believe that HDTV will come into wide use during the long operational lifetime of the station, and for this reason would like to employ a standard system.

Other Applications

In addition to the specific applications cited above, a number of other applications may have potential use in both the public and private sectors. These applications include high-definition galleries of works of art, and printing and electronic publishing. In addition, HDTV may improve some existing applications of conventional television technology.

High-Definition Gallery System

According to officials from the Japan Broadcasting Company, HDTV technology could be used to store, retrieve, and display high-quality pictures of works of art. The gallery could be constructed by storing a high-definition image of each work on a laser disc. Each work could then be easily retrieved from the disc on which hundreds of works of art are stored.

Japan Broadcasting Company officials believe such a system would be useful because galleries generally cannot exhibit all their works of art at the same time. The gallery system would allow the public access to all items at all times. Further, if this system were adopted by galleries and museums internationally, a worldwide network could be developed. Galleries in Japan and Canada have already put such HDTV systems into use.

Printing and Electronic Publishing

According to industry officials, HDTV makes it possible to quickly reproduce television images as high-quality still pictures. While it is possible to accomplish this with conventional television images, the resulting pictures were generally limited to use in news reporting because of the poor quality. HDTV, with twice the resolution of conventional television, makes it possible to widen the range of uses for these electronic images in the printing of documentary, science, and arts publications.

Vendors also projected that HDTV would result in various types of paper publications being replaced by collections of electronic images stored on discs. They saw this form of storage as being most applicable to highly visual publications, such as encyclopedias. In addition, this type of storage could be an appropriate way to store detailed pictorial information such as maps, blueprints, and textbooks.

Improvements to Existing Television Applications

Along with the new applications that may arise from HDTV, this technology may also improve the use of existing applications. Examples of these applications include:

- improved teleconferencing capabilities in which elaborate data images can be transmitted;
- security and surveillance systems using large, detailed displays;
- improved images for computer-aided design and computer- aided manufacturing systems; and
- improved presentation of computer-generated graphics.

Major Contributors to This Report

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